USAAVLABS TECHNICAL REPORT 65-64

TEST PROGRAM FOR AUTOMATIC LIGHT AIRCRAFT READINESS MONITOR

(Project ALARM)

FINAL REPORT

By

F. Prince Butler

Meyer B. Salomonsky

August 1965

U. S. ARMY AVIATION MATERIEL LABORATORIES

FORT EUSTIS, VIRGINIA

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SUMMARY

A U. S. Army Aviation Materiel Laboratories (USAAVLABS)* contract with Bendix Corporation was closed in January 1963. When the program under this contract was completed, it was concluded that it is feasible to determine the airworthiness of an aircraft at first echelon by using electronic means. The Automatic Light Aircraft Readiness Monitor (ALARM) system was built and subjected to limited testing by Bendix and was turned over to this Command when the contract was closed. This system consisted of a display panel and nine types of sensors. When a trouble area was detected by a sensor, a light was activated on the display panel. This Command, desiring (but lacking funds) to conduct a test program to determine the effectiveness of the system, initiated a limited test program to use the same ALARM system and one UH-1 aircraft. This report covers approximately 100 flight hours of this program.

The test program consisted of (1) conducting limited laboratory tests, (2) recording all no-go readings of the ALARM system, (3) recording the actual vibration and temperature readings of the vibration and temperature channels, and (4) recording all malfunctions of the aircraft. Comparisons of the no-go readings and the actual vibration and temperature readings with the malfunction data indicate that the ALARM system, as installed, could be used as an operational system. There were 24 ALARM system malfunction indications during the test period, 22 of which were verified as actual malfunctions. Every malfunction that could possibly have been detected by the ALARM system was discovered.

The test results indicate that the following future work must be performed before the ALARM system can become operational:

1. Minor modifications are required on two of the nine types of channels.

2. Major modifications are required on two of the nine types of channels.

3. Additional tests involving not less than six test aircraft of the same model must be conducted to obtain normal operating levels of the temperature and vibration channels for more than one aircraft, to verify the reliability and accuracy of the chip detector channels, and to generate design data for a development program.

4. The engine speed channel should be eliminated from the system.

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*Formerly, U. S. Army Transportation Research Command (USATRECOM).

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INTRODUCTION

In 1960 this Command entered into a contract with the Bendix Corporation, York Division, York, Pennsylvania, to study the feasibility of using electronic means to determine, at first echelon, the airworthiness of an aircraft. Under this contract, a Light Aircraft Readiness Monitor (ALARM) system was fabricated and a limited test program was conducted. When this program was conceived, it was anticipated that normal levels of operating temperatures, pressures, and vibrations would be available from aircraft manufacturers. However, solicitation of this information from aircraft engine and airframe manufacturers revealed that it would be necessary to accumulate data to determine these normal levels before the practicality of the system could be fully determined. The results of the limited tests indicated that the ALARM system concept is feasible. However, because not enough data were accumulated to establish the normal operating levels, it was concluded that the system would not work sufficiently well to initiate a development program. It was determined at the conclusion of the contractual effort that several hundred flight hours, on more than one aircraft, would have to be monitored by the ALARM system to establish operation norms, to analyze deviations from normal patterns by comparing them with malfunction data, and to determine the true value of each channel in the system.

Lack of funds precluded an all-out effort. However, a limited in-house program to conduct approximately 100 flight hours on a UH-1A model aircraft was initiated. This report covers the results of the tests.

The experimental procedures for the in-house tests consisted of (1) conducting limited laboratory tests; (2) recording all no-go readings of the ALARM system; (3) recording the actual vibration and temperature readings of the vibration and temperature channels; and (4) recording all malfunctions of the aircraft.

The readings for each of the nine types of ALARM channels are compared individually with the aircraft malfunction data in the body of this report.

It is important to recognize that the ALARM system, by itself, is not a complete diagnostic system but is an inspection tool to be used at the lower echelons of maintenance as well as by the pilot and crew chief. A no-go indication by the ALARM system serves as a warning that a detailed inspection of the particular area giving the no-go signal is required.

CONCLUSIONS

It is concluded that:

1. To indicate trouble areas, it is feasible to use the following ALARM channels:

   Security Channels

   These are reliable and could be used by an operational ALARM system if the roller leaf actuators of the sensors located on the transmission access cowls were modified to provide the required durability.

   Oil Level Channels

   These are reliable and could be used in their present configurations by an operational ALARM system.

   Vibration Channels

   Insufficient data are available to determine the detection levels for all UH-1 aircraft.

   Oil Flow (Oil Leak) Channel

   This channel is reliable and could be used in its present configuration by an operational ALARM system.

   Temperature Channels

   The detection levels should be designed to adjust 1° C for every 1° C change in ambient temperature. Insufficient data are available to determine the detection levels for all UH-1 aircraft.

2. Additional data are required to determine the accuracy of the chip detector channels. (The use of a chip detector channel to indicate a trouble area is assumed to be feasible, based on previous work in this field.)

3. The filter bypass and pressure relief valve channels do not yield sufficient sensitivity in their present configurations to be used in an operational ALARM system.

4. The engine speed channel does not provide useful or accurate information in its present configuration.

RECOMMENDATIONS

It is recommended that:

1. The ALARM system be modified to provide the following characteristics:

   a. Greater durability of the roller leaf actuators of the security channel sensors located on the transmission access cowls.

   b. A temperature channel detection level adjustment of 1° C for every 1° C change in the ambient temperature.

   c. Greater sensitivity of the filter bypass channels and the pressure relief valve channel.

2. A program using not less than six test aircraft of the same model and involving not less than 200 flight hours per aircraft be conducted to obtain data for the following purposes:

   a. To determine the reliability and accuracy of the chip detector sensors, the modified filter bypass sensors, and the modified transmission pressure relief valve sensors.

   b. To determine valid detection levels for the vibration and temperature channels and to establish vibration and temperature trends as functions of aircraft malfunctions.

   c. To determine the discrete frequency bands at which an amplitude increase can be expected to occur, for each vibration channel, when there is a malfunction in the aircraft.

   d. To generate design data to be used for a development program.

3. The engine speed channel be eliminated from the ALARM system.

DESCRIPTION OF ALARM SYSTEM

The ALARM system consists of two components: the display panel and the sensors with associated circuits.

DISPLAY PANEL

The display panel is an array of indicator lights, which are located within easy view of the pilot or a crew member (see Figure 1). Each light represents one ALARM channel, which is activated by one or more sensors, the location and type of which are printed on the light. The activation of a light indicates that there is a trouble area on the aircraft. Table I shows a list of the channels.

Figure 1. ALARM Display Panel.

TABLE I
CHANNEL IDENTIFICATION

Category	Channel Number	Location
Security	1	Forward
	2	Left Aft
	3	Right Aft
	4	Filler Cap
	5	Spare
Oil Level	6	Transmission
	7	Engine
	8	Gearbox, 90 Degrees
	9	Gearbox, 42 Degrees
	10	Spare
Chip Detector	11	Transmission
	12	Gearbox, Acceleration
	13	Gearbox, 42 Degrees
	14	Gearbox, 90 Degrees
	15	Spare
Filter Bypass	16	Transmission
	17	Fuel
	18	Engine
Pressure Relief Valve	19	Transmission
	20	Spare
Vibration	21	Transmission Top
	22	Transmission Base
	23	Aft Engine
	24	Forward Engine
	25	Tail
	26	Low Frequency Mast
	27	Spare
Engine Speed	28	Engine
Engine Oil Flow	29	Engine
	30	Spare

TABLE I (contd)

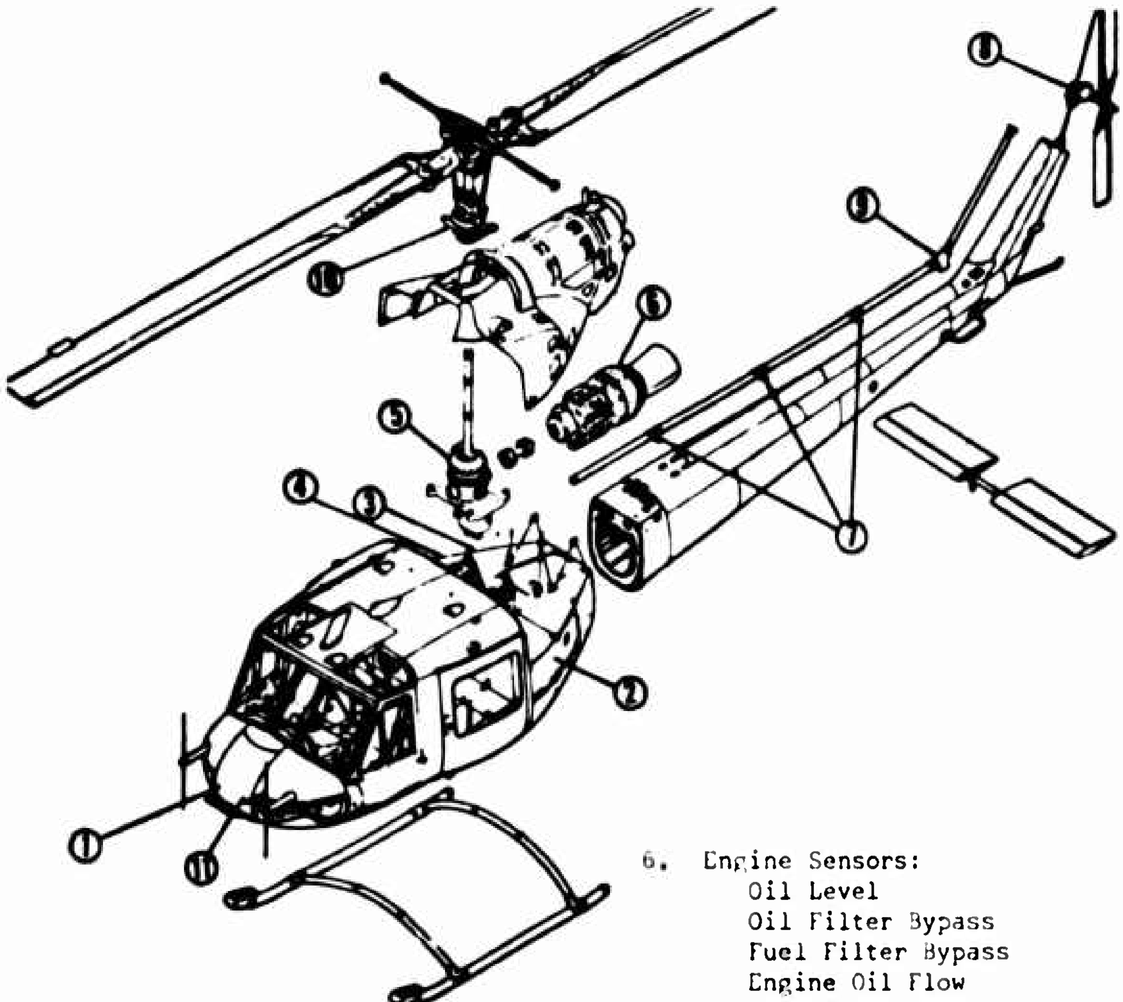
Category	Channel Number	Location
Temperature	31	Swash Plate
	32	Main Mast Bearing
	33	Forward Hangar Bearing
	34	Mid Hangar Bearing
	35	Aft Hangar Bearing
	36	Gearbox, 42 Degrees
	37	Gearbox, 90 Degrees
	38	Spare
	39	Spare
	40	Spare

SENSORS

The sensors for the ALARM system are of various types and are located throughout the aircraft. The sensor types are divided into the following categories: security, liquid level, chip detector, filter bypass, transmission pressure relief valve, vibration, speed, oil flow, and temperature. The locations of all the sensors are shown in Figure 2. There is only one sensor per channel, except for the security channels, for which a breakdown is shown in Table II.

TABLE II
SECURITY CHANNEL GROUPING

Channel Number	Legend Title	Monitored Points
1	Forward Door	Nose Door (Two Switches)
		Left Crew Door (One Switch)
		Right Crew Door (One Switch)
		Left Cargo Door (One Switch)
		Right Cargo Door (One Switch)
2	Left Aft	Three Left Aft Access Doors (Three Switches)
		Left-Side Transmission Cowling (Two Switches)
		Left-Side Engine Cowling (One Switch)
3	Right Aft	Three Right Aft Access Doors (Three Switches)
		Right-Side Transmission Cowling (One Switch)
		Right-Side Engine Cowling (One Switch)
4	Filler Cap	Engine Oil Filler Cap (One Switch)
		Transmission Oil Filler Cap (One Switch)
		Hydraulic Filler Cap (One Switch)



6. Engine Sensors:
   - Oil Level
   - Oil Filter Bypass
   - Fuel Filter Bypass
   - Engine Oil Flow
   - Chip Detector
   - Forward Engine Vibration
   - Rear Engine Vibration
7. Shaft Hangar Bearings Temperature
8. Ninety-Degree Gearbox Sensors:
   - Oil Level
   - Gearbox Temperature
   - Chip Detector
   - Tail Vibration
9. Forty-Two-Degree Gearbox Sensors:
   - Oil Level
   - Gearbox Temperature
   - Chip Detector
10. Swash Plate Bearing Temperature
11. Low Frequency Frame Vibration

1. Forward Door Interlocks (See Table II)
2. Left Aft Interlocks (See Table II)
3. Right Aft Interlocks (See Table II)
4. Filler Cap Security (See Table II)
5. Transmission Sensors:
   - Oil Level
   - Oil Filter Bypass
   - Pressure Relief Valve
   - Chip Detector
   - Vibration, Upper
   - Vibration, Lower
   - Mast Bearing Temperature

Figure 2. ALARM Sensors, General Location.

DISCUSSION

SECURITY CHANNELS

DESCRIPTION

Four channels are installed on the test aircraft to ensure that the doors, filler caps, and cowlings are secured prior to and during flight. The sensors for these channels are electrical continuity switches. If a monitored component is not secured, the electrical continuity switch is opened and the ALARM system is activated.

Originally, this channel was intended to give no-go indications during only ground operations; however, during this test period, the channel was modified to give no-go indications during flight also.

TEST PROCEDURES

During the test period covered by this report, the reliability and durability of the security sensors and the associated circuits were periodically tested. Each of the four channels was observed as the appropriate sensors were activated and deactivated. These channels were also constantly monitored during the dynamic and flight phases of the tests.

TEST RESULTS

Prior to taking off on numerous occasions, the pilot of the test aircraft was warned by the ALARM system of a door or filler cap which had not been secured. In all known cases of doors or filler caps that were not secured, both in flight and on ground, no-go indications were provided by the system.

Maintenance-free operation was noted in all but one area: The transmission cowls on both sides of the ship close with a sliding action, and in some cases, the roller leaf actuators of the security sensors were broken. It is felt that this deficiency could be corrected if the sensors were considered in the initial design phase of the aircraft rather than after the aircraft had been developed.

Two doors on the test aircraft were lost during this report period as a result of their not being secure. In both cases, the ALARM system was not undergoing test and therefore was not in operation. Had it been in operation, the doors probably would not have been lost.

CONCLUSIONS

It is concluded that the ability of the security channels to indicate no-go conditions both in flight and on ground is highly reliable.

OIL LEVEL CHANNELS

DESCRIPTION

Four channels are installed on the test aircraft to detect underfilled or overfilled oil level conditions. Each channel has two thermistors for sensors; one is located above the proper oil level and the other is located below the proper oil level. When the oil is at the proper level, there is a temperature differential between the two sensors, since one sensor is in oil and the other is in air. When the oil level is in an underfilled or overfilled condition, the two sensors are in air or in oil respectively and, therefore, there is no temperature differential. The ALARM system is activated when there is no temperature differential between the two sensors.

TEST PROCEDURES

Periodically, oil was added to the reservoirs until overfilled conditions were attained and indications were noted on the ALARM panel. The reservoirs were drained until underfilled conditions occurred; again, indications were noted on the ALARM panel. These tests were conducted with the aircraft in the static condition. The oil levels were also constantly monitored during the flight phase of the tests.

TEST RESULTS

The results obtained from the test program indicate that the circuits of the oil level channels are reliable. Tests conducted on the 42-degree and 90-degree gearboxes indicated that plus or minus 1/2 pint of oil was sufficient to create no-go readings. Tests conducted on the engine and transmission reservoirs indicated that plus or minus 2-3/4 quarts were sufficient to create no-go readings.

There were three no-go indications noted for these channels during the flight phase of the tests. The 90-degree gearbox was underfilled once and overfilled once, and the engine reservoir was underfilled once. All known cases of improper oil level were detected by the ALARM system.

CONCLUSIONS

It is concluded that these channels are reliable and that they could be used in their present configuration by an operational ALARM system.

CHIP DETECTOR CHANNELS

DESCRIPTION

Four chip detector channels are installed on the test aircraft to determine if the steel chip content of the oil in gearboxes exceeds the acceptable level. The sensors for these channels are composed of two electric terminals, the positive terminal being magnetized. When there is a buildup of steel chips in the gearbox, the chips are drawn to the magnet, so that the circuit between the positive and negative terminals is closed, and, in turn, the ALARM system is activated.

TEST PROCEDURES

The chip detector channels were constantly monitored during the dynamic and flight phases of the tests.

TEST RESULTS

The only no-go indication recorded for the chip detector channels during this test period was one for the accessory gearbox. Following this no-go indication, the sensor was removed, cleaned, and reinstalled. Had the no-go indication been repeated, the accessory gearbox would have been disassembled to determine the condition of the gears. The no-go indication was not repeated.

CONCLUSIONS

It is concluded that additional data are needed to determine the effectiveness of the chip detector channels.

FILTER BYPASS CHANNELS

DESCRIPTION

Three channels are installed on the test aircraft to determine the condition of the oil filters. The sensors for these channels are magnetic switches which are activated by the movement of the stems of existing filter bypass valves. Blockage of the filter causes a buildup of pressure and activation of the bypass valve which, in turn, activates the sensor.

TEST PROCEDURES

At the beginning of this test period, laboratory tests were conducted to determine the sensitivity of these channels. The channels were also constantly monitored during the dynamic and flight phases of the tests.

TEST RESULTS

The laboratory tests indicated that there is virtually no increase in intake line pressure until there is 74-percent filter blockage and that the relief valve is not triggered until approximately 95-percent filter blockage is attained. No no-go readings were obtained; however, the low sensitivity of the sensors does not permit conclusions to be drawn from this result.

CONCLUSIONS

It is concluded that the oil filter channels do not yield sufficient sensitivity in their present configuration. Therefore, it will be necessary to redesign these channels before they can be used for an operational ALARM system.

TRANSMISSION PRESSURE RELIEF VALVE CHANNEL

DESCRIPTION

One channel is installed on the test aircraft to detect the blockage of one or more transmission oil jets. The sensor for this channel is an electrical continuity switch mounted on the existing transmission pressure relief valve (PRV). If one or more oil jets are blocked, pressure builds up in the transmission case, the PRV is opened, and, in turn, the electrical continuity switch is closed.

TEST PROCEDURES

Tests were conducted in the laboratory to determine the sensitivity of this sensor. The PRV channel was monitored constantly during the dynamic and flight phases of the tests.

TEST RESULTS

No no-go indications were obtained from this channel. In the laboratory tests, it was demonstrated that this channel does not yield enough sensitivity to indicate a no-go condition with one jet blocked.

CONCLUSIONS

The low sensitivity of this channel does not permit conclusions to be drawn from this result; therefore, it will be necessary to modify the sensor and/or the PRV before this channel can be used for an operational ALARM system.

VIBRATION CHANNELS

DESCRIPTION

Six channels are installed on the test aircraft to inform the pilot of above-normal vibration levels at monitored points on the aircraft. The sensors for these channels are two accelerometers and four velocity pickups which feed electrical signals into the ALARM system; the signals are proportional to the vibtation levels at the points being monitored. The ALARM system is activated when these signals exceed predetermined limits.

TEST PROCEDURES

The actual voltage readings of each of the sensors were recorded during dynamic and flight tests. The vibration levels of the sensors were calculated and plotted versus engine operating hours. Limited data were recorded for the forward engine channel because of a malfunction in the forward engine sensor throughout a large portion of the test period. Ground readings were discontinued after 330 engine hours to decrease the time required to monitor all channels during a flight.

TEST RESULTS

During some test flights, many readings were omitted because of lack of time; thus, large gaps were left between some readings. An example of this can be seen in Figure 4 (page 18) for the 60-knot plot between engine hours 330 and 370. In such cases, the line joining the two points cannot be considered as representative of the actual vibration level and is only included for continuity.

Figures 5 through 9 display the vibration levels of various components of the aircraft versus engine hours. Superimposed on each of these graphs are descriptions of the major repairs performed on the aircraft during the test period. Each of the vibration levels recorded was taken through a frequency band wide enough to include all significant vibrations of the respective component. Most noteworthy of the vibration plots is that of the tail vibration, Figure 5, which displays a climb in the vibration level beginning at 330 engine hours. The climb continued to the 370-engine-hour reading; then, a bent tail rotor shaft and three cracks in the tail boom were repaired and the engine was replaced. The vibration level took a substantial drop immediately following these repairs; however, it did not drop to the normal operating level until the engine drive shaft was adjusted at 377 engine hours and the main rotor was tracked at 385 engine hours.

The cracks in the tail boom were discovered during a detailed inspection that was initiated because of the unusually high ALARM tail vibration readings. The locations of these cracks are shown in Figure 3. These cracks were not detected by conventional maintenance methods, and, had the unusually high ALARM vibration indications not occurred, the detailed inspection would not have been made.

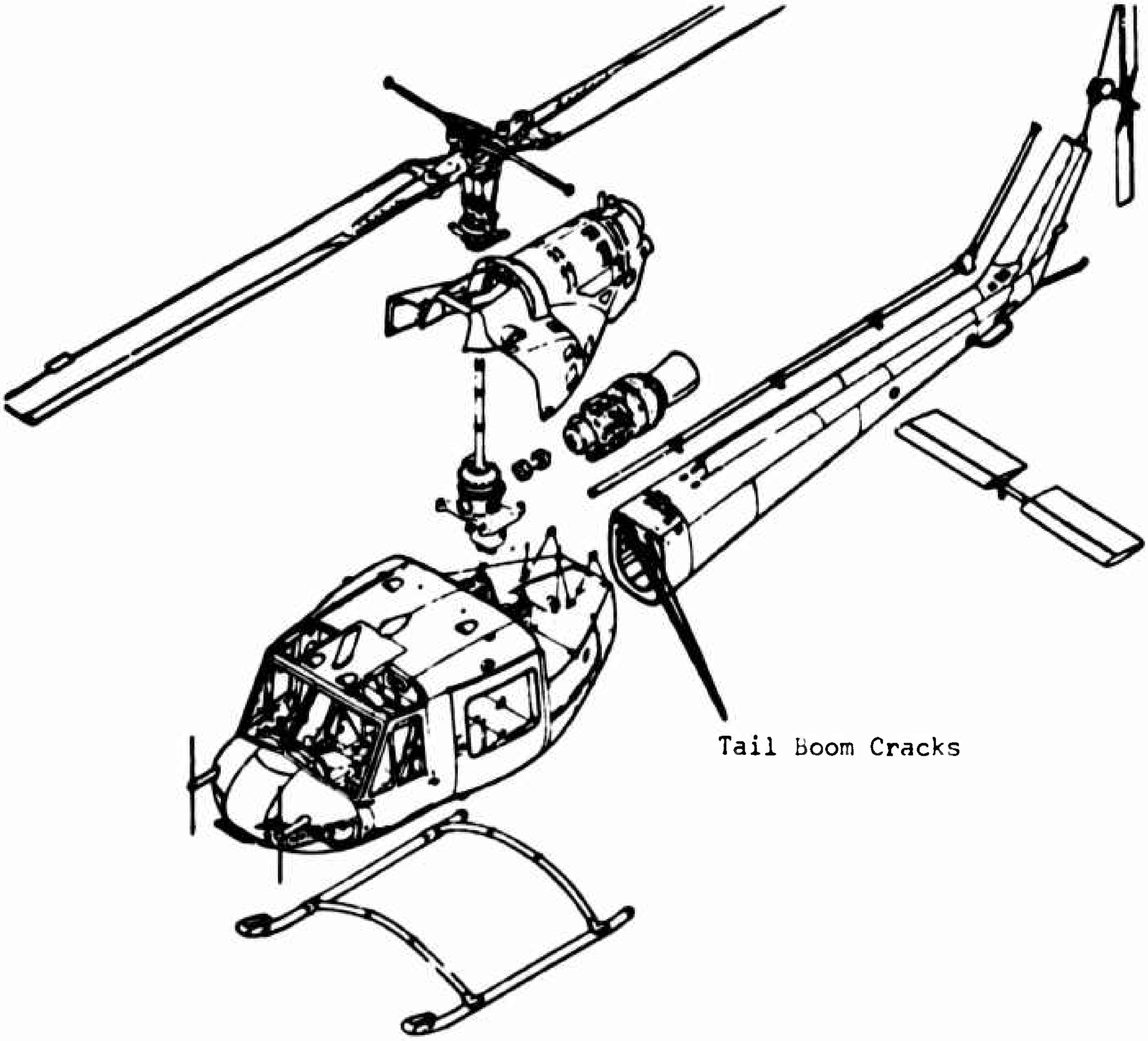


Figure 3. Tail Boom Cracks From Vibration.

The low frequency plots (Figure 4) for 80 knots and 60 knots indicate that there was a steady increase in the vibration level until the engine drive shaft was replaced at 363 engine hours, at which point the vibration level decreased sharply. Upon replacement of the engine, at 375 engine hours, the vibration level increased sharply. At 377 engine hours, the main rotor was tracked and the drive shaft was adjusted; the vibration level then dropped to the normal operation level.

An interesting feature displayed by the transmission plots, Figures 6 and 7, is that at 330 engine hours the vibration level of the transmission top began to decrease and that of the transmission base to increase. These trends continued until the end of the test period, although no explanation presented itself for these phenomena.

Tightening the collective sleeve at 287 engine hours and modifying the hangar assembly at 307 engine hours did not significantly affect any of the vibration plots. This was expected and is not considered to be important because both of these adjustments are minor and neither was made necessary by a malfunction of the test aircraft.

Because of the lack of data pertaining to normal operating vibration levels at the beginning of the test program, the detection levels were arbitrarily chosen; therefore, very little emphasis was placed on the no-go indications for these channels.

The data from which the frequency plots were drawn are not highly accurate because of the method used to obtain them. Each vibration level was read from a voltmeter connected directly to the respective channel. The movement of the aircraft caused constant movement of the voltmeter needle, making it necessary for the reader to estimate the reading. It was also necessary to read each channel individually, thus creating a time lapse between the readings.

CONCLUSIONS

The results of this program clearly demonstrate that a malfunction of some components of the aircraft can be detected by the vibration channels before they are discovered by conventional means. However, before the vibration channels can be used in an operational ALARM system, more data must be obtained to make a better determination of the correlation between vibration levels and aircraft malfunctions. It is believed that the vibration channels would be more sensitive if those frequencies that do not increase in amplitude as a function of malfunctions were filtered out. To do this, it will be necessary to investigate future vibration data to determine the discrete frequency bands at which an amplitude increase can be expected to occur when there is a malfunction in the aircraft.

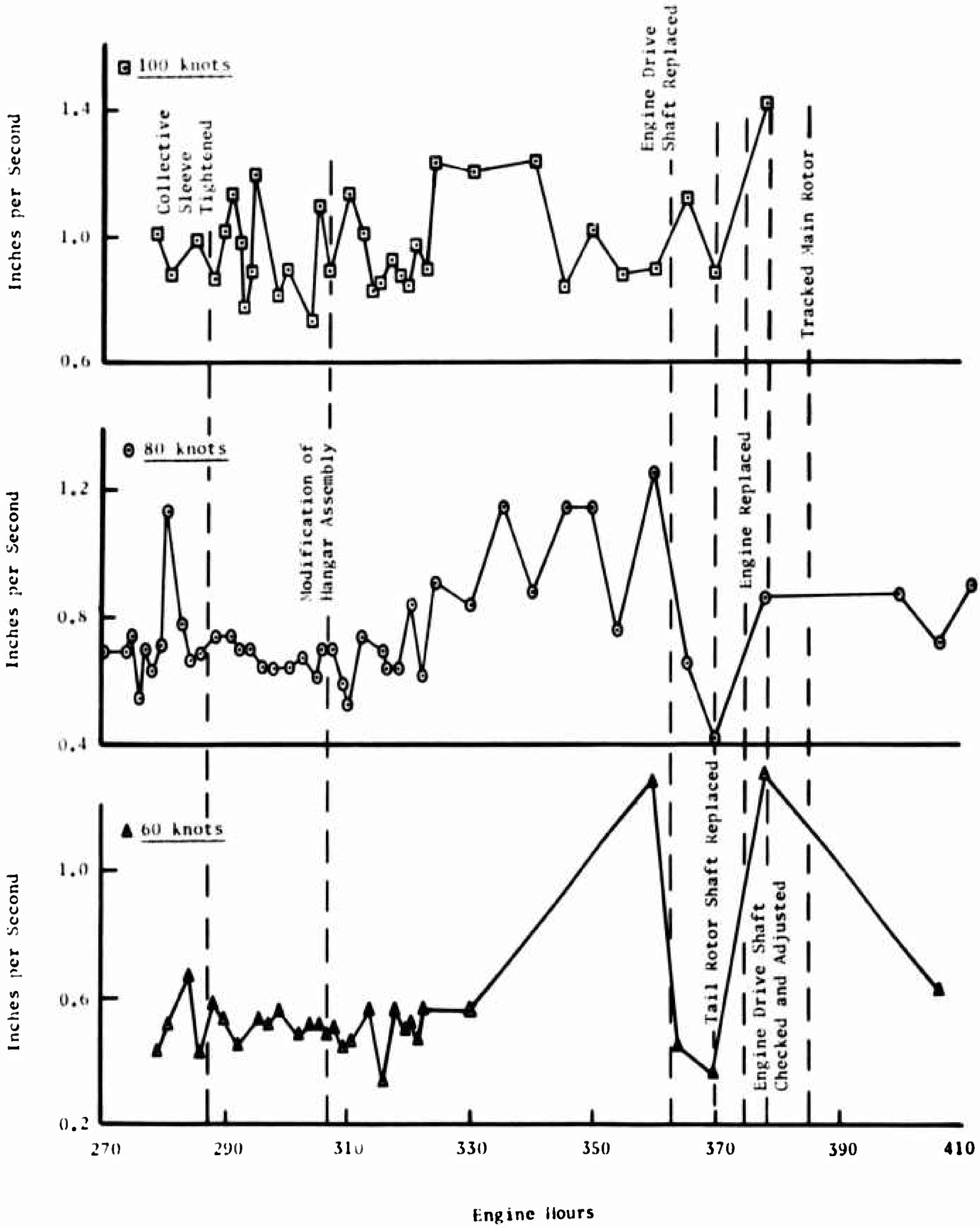


Figure 4. Low Frequency Vibration (3 to 100 cps).

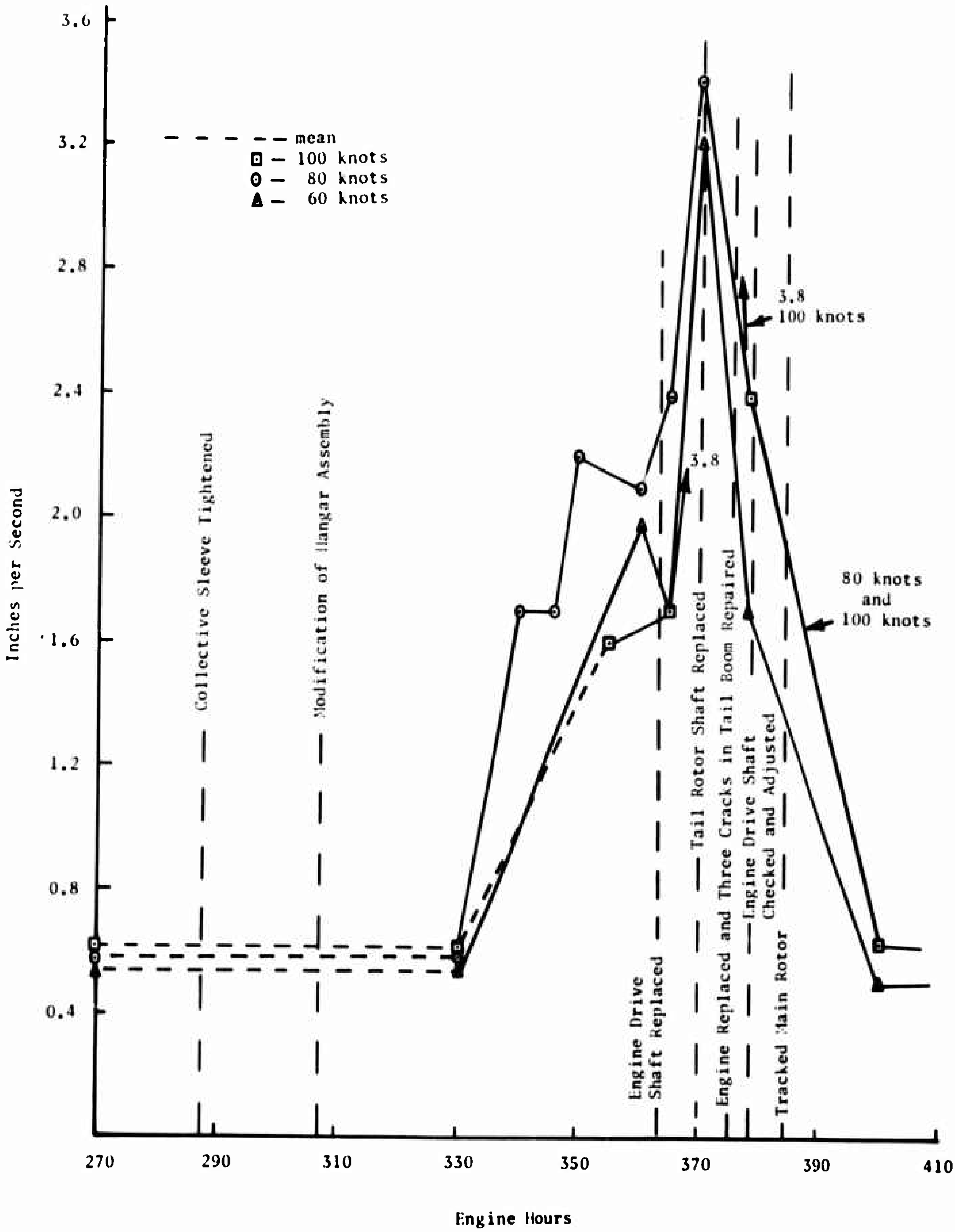


Figure 5. Tail Vibration (20 to 2,000 cps).

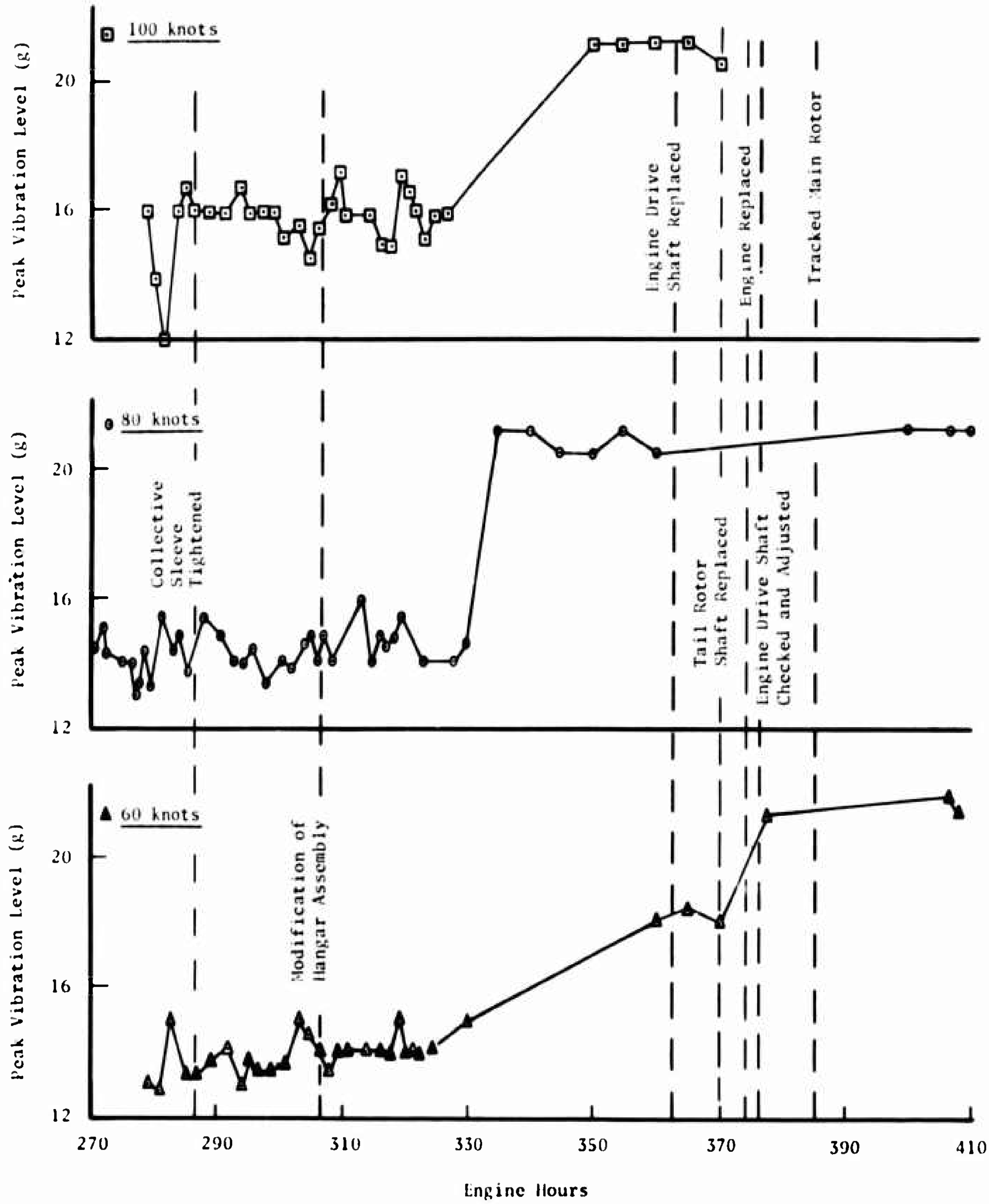


Figure 6. Transmission Base Vibration (500 to 20,000 cps).

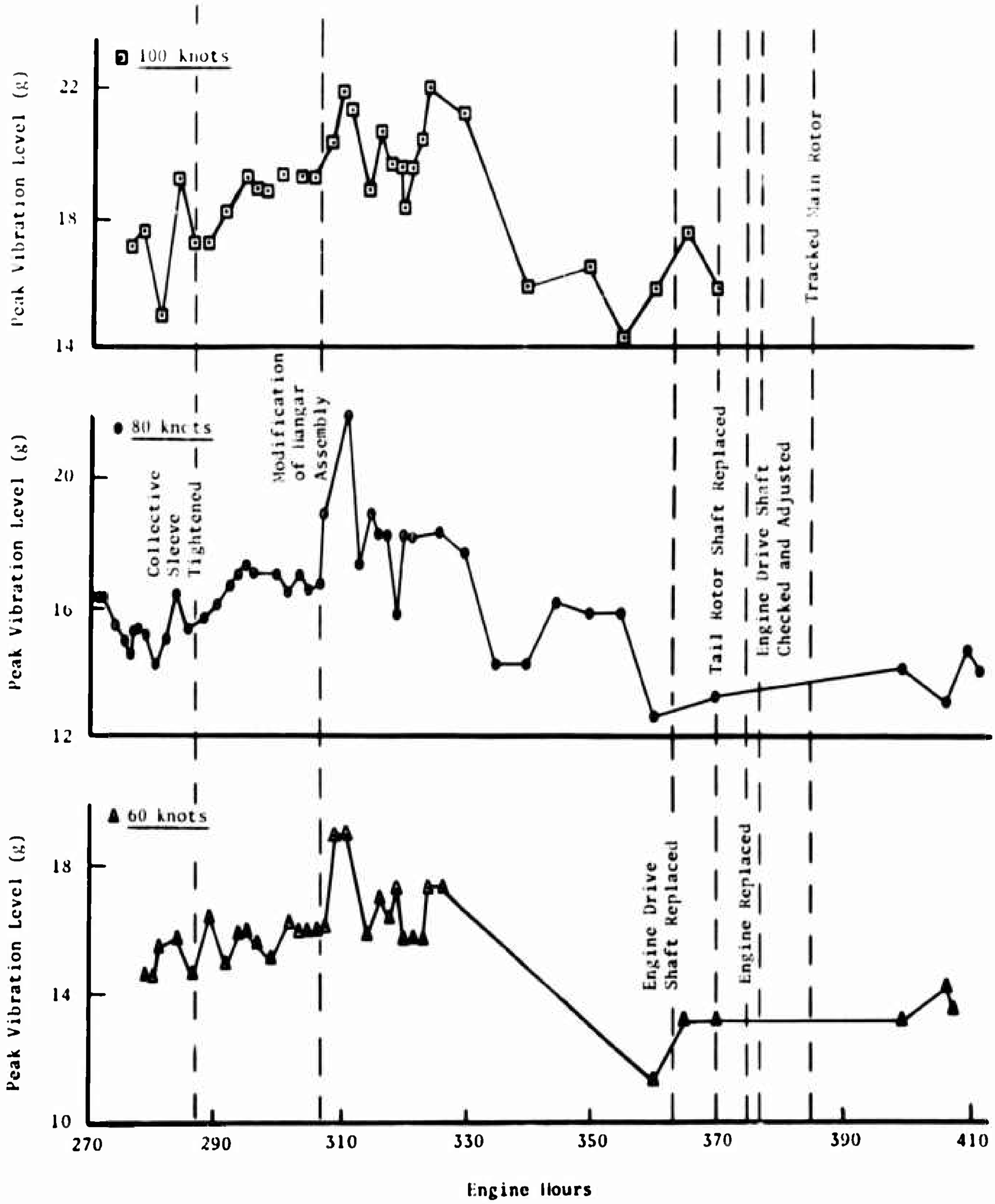


Figure 7. Transmission Top Vibration (500 to 20, 000 cps).

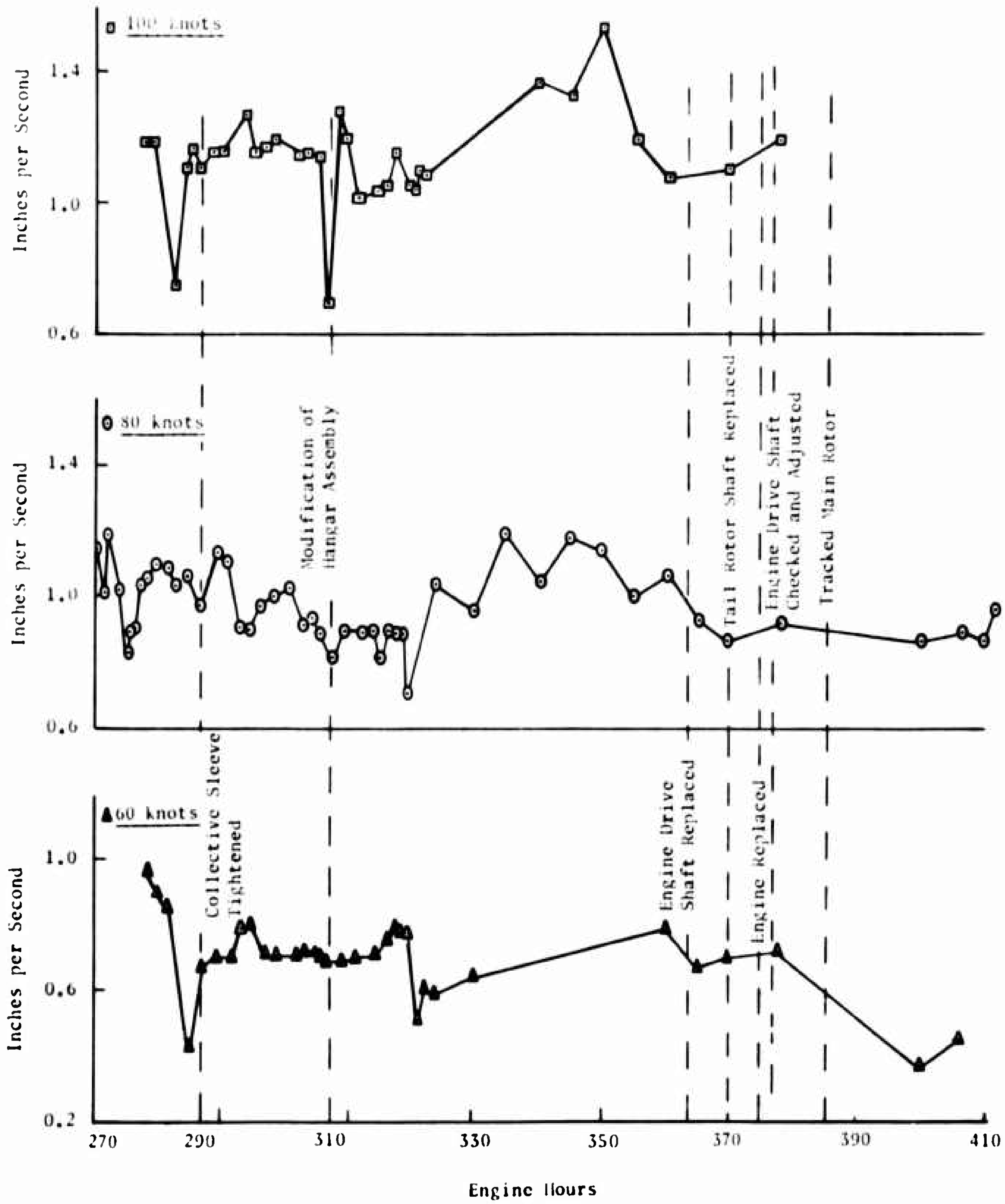


Figure 8. Aft Engine Vibration (20 to 2,000 cps).

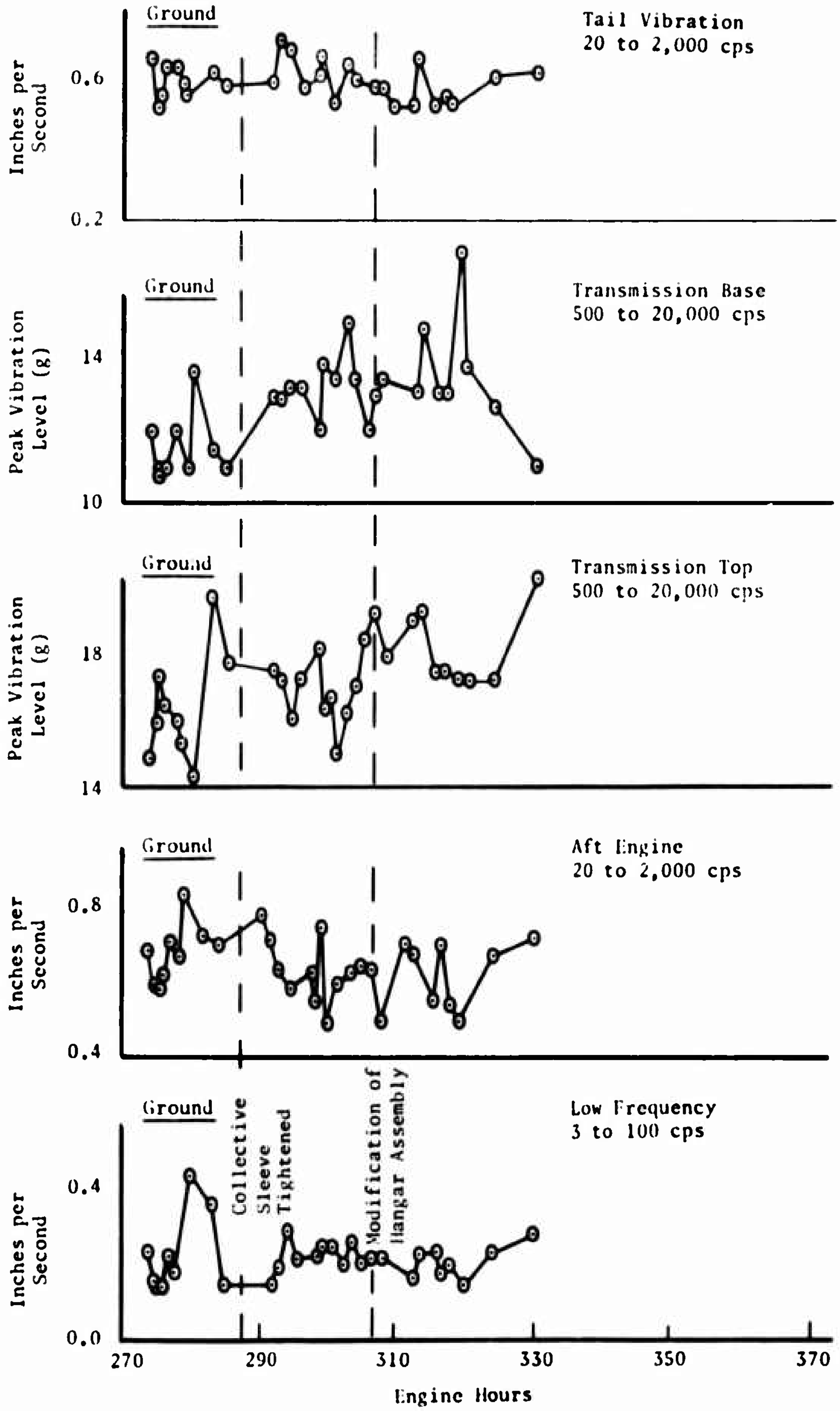


Figure 9. Ground Vibration.

ENGINE SPEED CHANNEL

DESCRIPTION

One channel is installed on the test aircraft to detect engine overspeed and underspeed conditions. This channel uses the existing tachometer generator as a sensor. The lower limit of this channel provides a warning of turbine flameout, and the upper limit informs the pilot of engine overspeed.

TEST PROCEDURES

The engine speed channel was constantly monitored during the dynamic and flight phases of the tests.

TEST RESULTS

Erroneous no-go indications were obtained from this channel as a result of excessive temperature drift of the channel no-go detection level.

CONCLUSIONS

It is concluded that this channel does not provide meaningful information in its present configuration. Based on observations made during the tests covered by this report and on previous studies discussed in TRECOM Technical Report 63-10,* this channel will be eliminated from the ALARM system. The information provided by this channel would not be of sufficient value to warrant the expenditure of funds necessary for its development. The flameout warning would not be fast enough to be of practical value because of the 3- to 5-second coast-down delay of the shaft, and the information provided by the upper limit of this channel is already available to the pilot from his rpm meter.

*Automatic Light Aircraft Readiness Monitor (Project ALARM), Volume I, U.S. Army Aviation Materiel Laboratories (formerly U. S. Army Transportation Research Command), Fort Eustis, Virginia, January 1963, page 40.

ENGINE OIL FLOW CHANNEL

DESCRIPTION

One oil flow channel is installed on the test aircraft to detect any leak in the oil system. The sensor for this channel is a turbo-type flowmeter which detects an increase in oil flow caused by an oil leak.

PROCEDURES

The engine oil flow channel was constantly monitored during the dynamic and flight phases of the tests.

TEST RESULTS

During the test flights, two no-go signals indicated the only oil leaks that were discovered. These leaks, one caused by a defective o-ring in the oil line and the other by a loose oil filter connection, were not reflected by an oil pressure drop on the pilot's instrument panel.

CONCLUSIONS

It is concluded that this channel is highly reliable, provides accurate and useful information, and could be used in its present configuration by an operational ALARM system.

TEMPERATURE CHANNELS

DESCRIPTION

Seven temperature channels are located on the test aircraft. The sensors for these channels are thermal ribbons that detect above-normal temperatures for the components they are monitoring.

At the beginning of the test period, tests were conducted to determine the location at which the ambient temperature could be accurately sensed. These tests indicated that accurate ambient temperature readings could be

sensed on the inner surface of the access door to the oil cooler compartment. The ambient generator was relocated to this point.

TEST PROCEDURE

The no-go indicators for these channels were constantly monitored, and the actual voltage readings of each of the sensors were recorded during dynamic and flight tests. The temperatures of the sensors were calculated and plotted versus the ambient temperature, as determined from the ambient generator channel readings. These plots can be found in Figures 10 through 16. The detection levels for each of the temperature channels are superimposed on the respective graphs. The temperature detection levels were designed to adjust automatically 1° C for every 2° C change in ambient temperature.

TEST RESULTS

Three no-go indications were obtained during the dynamic and flight tests. One was sensed by the aft shaft bearing sensor (see Figure 12) and two were sensed by the swash plate bearing sensor (see Figure 13).

In all three of these instances, it was determined that the bearings yielding the no-go readings were contaminated. Upon removing, purging, and reinstalling the bearings, the respective sensors gave normal operating readings.

On all of the temperature channel plots, it can be seen that the detection levels are not parallel with the series of readings taken during the test period. It is important that the temperature differential between the normal operating level and the detection level be constant at all values of the ambient temperature. Therefore, it is desirable that the detection level and readings taken when the aircraft is operating normally fall in parallel lines. The readings taken during the test period fall on a line which increases 1° C in sensor temperature for every 1° C change in ambient temperature.

CONCLUSIONS

It is concluded that the temperature channels of the ALARM system can be used to detect contaminated bearings.

It is further concluded that the detection level should not have been designed to adjust 1° C for every 2° C change in ambient temperature and that these

channels must be redesigned to provide for a detection level that will adjust 1° C for every 1° C change in ambient temperature.

It will be necessary to accumulate more data before the exact relationship between temperature and malfunctions can be determined.

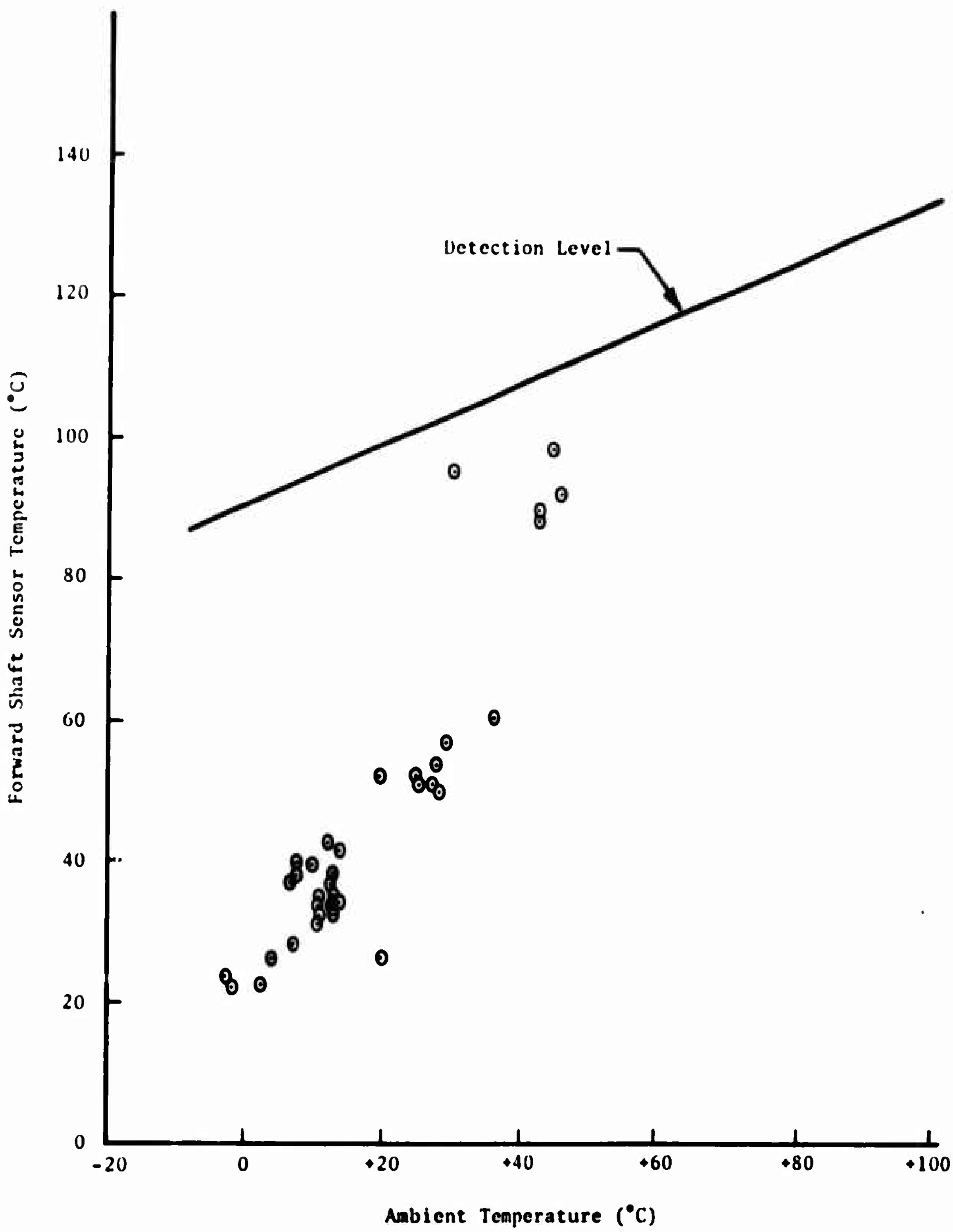


Figure 10. Forward Shaft Bearing Sensor Temperature Versus Ambient Temperature.

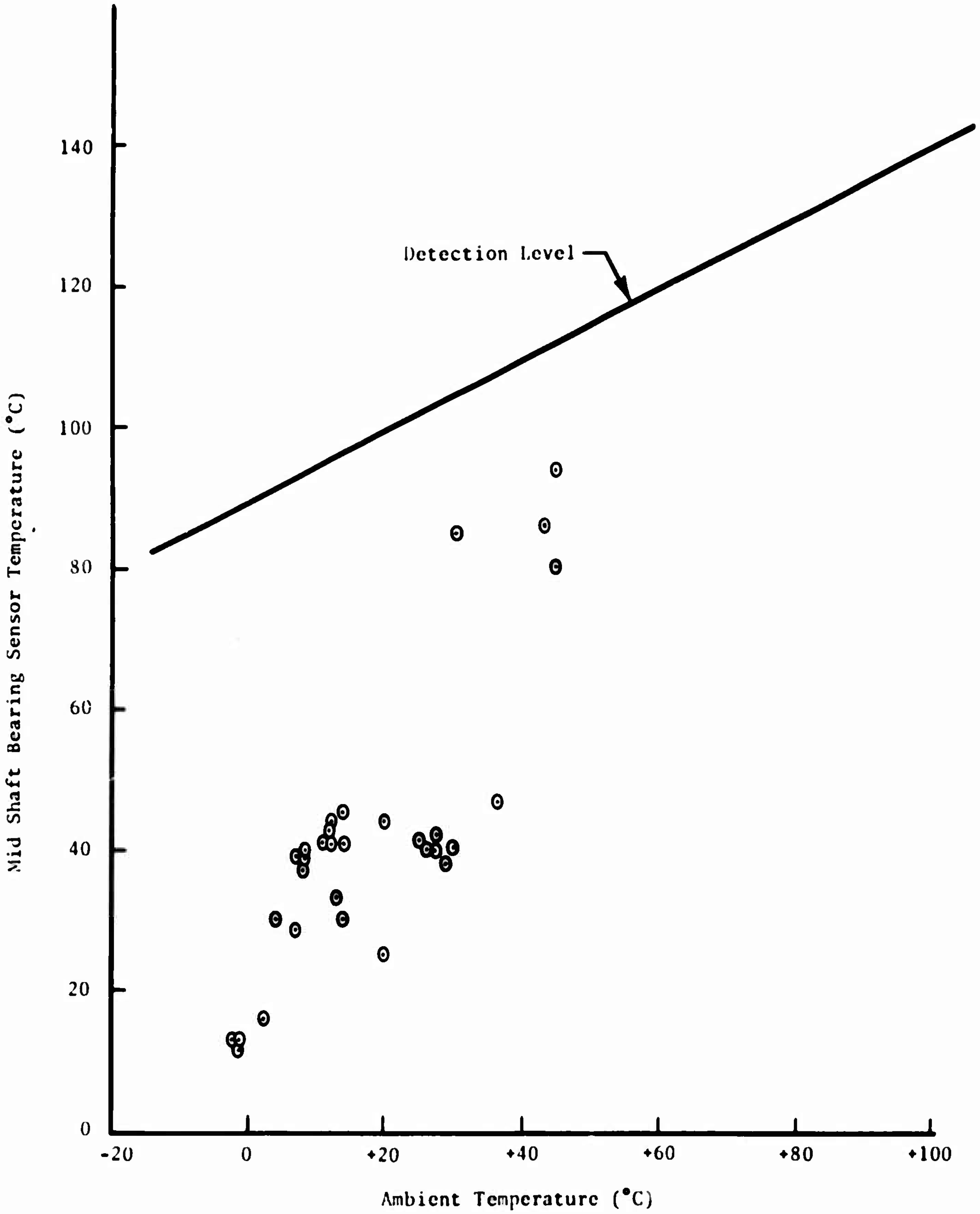


Figure 11. Mid Shaft Bearing Sensor Temperature Versus Ambient Temperature.

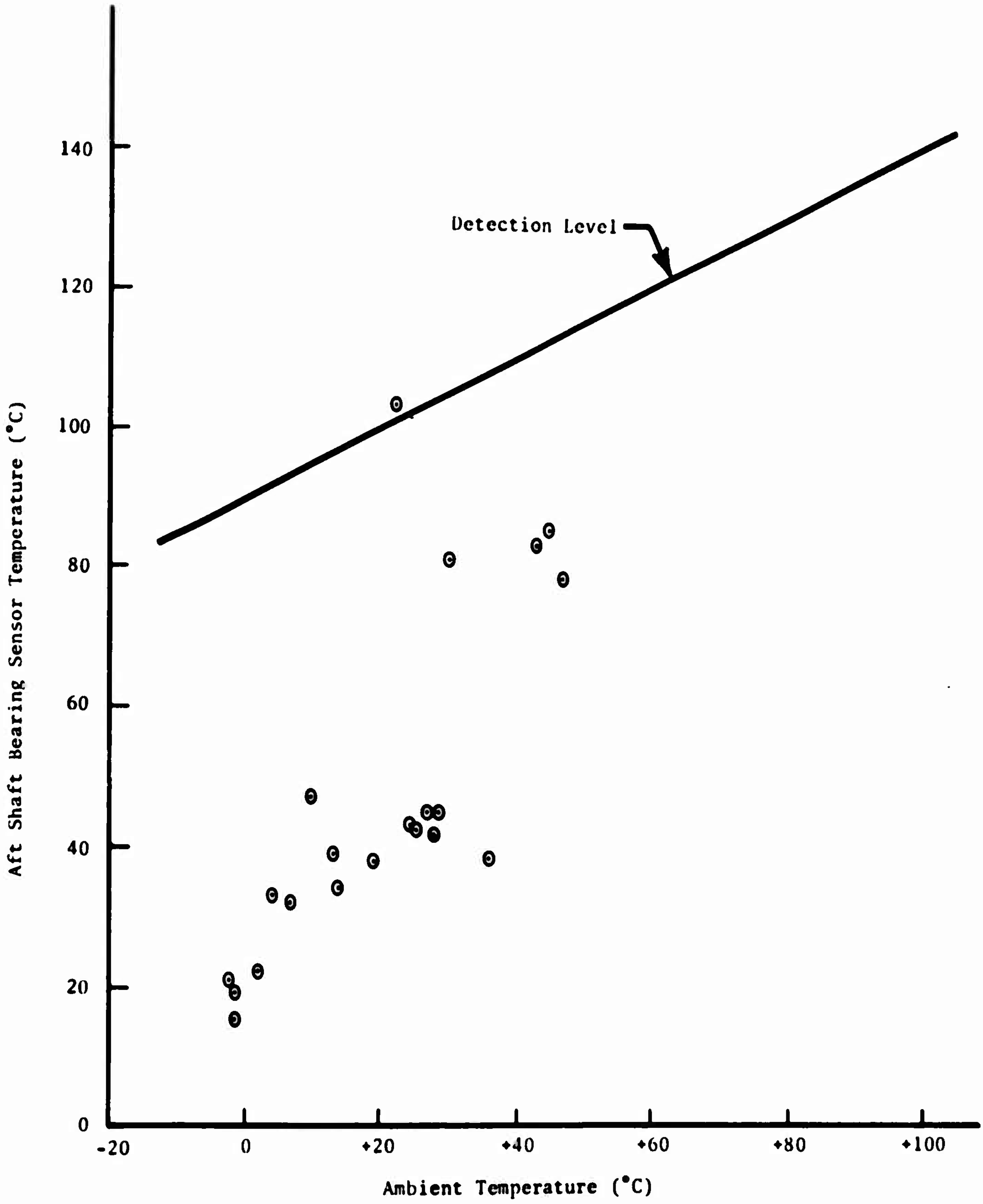


Figure 12. Aft Shaft Bearing Sensor Temperature Versus Ambient Temperature.

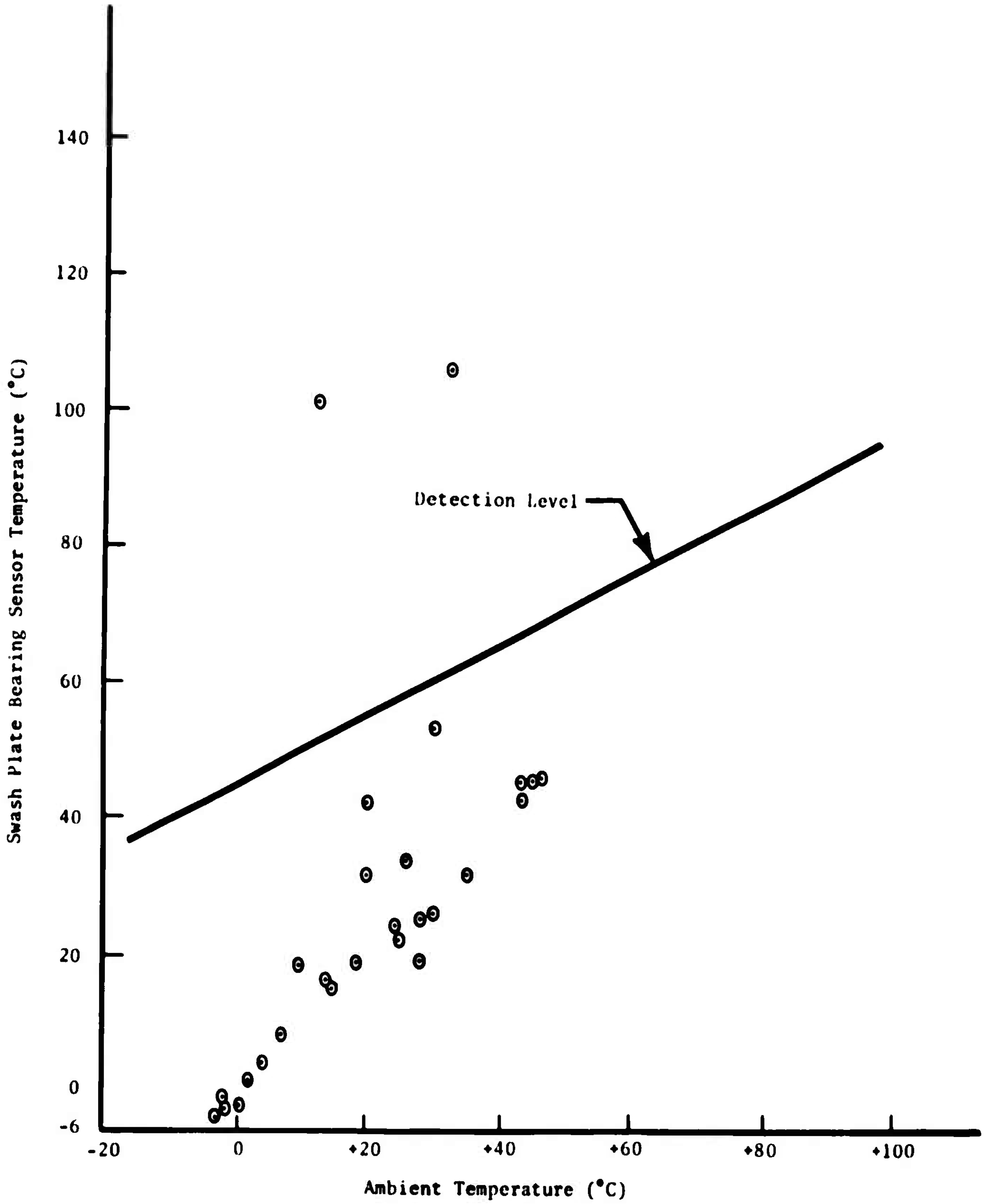


Figure 13. Swash Plate Bearing Sensor Temperature Versus Ambient Temperature.

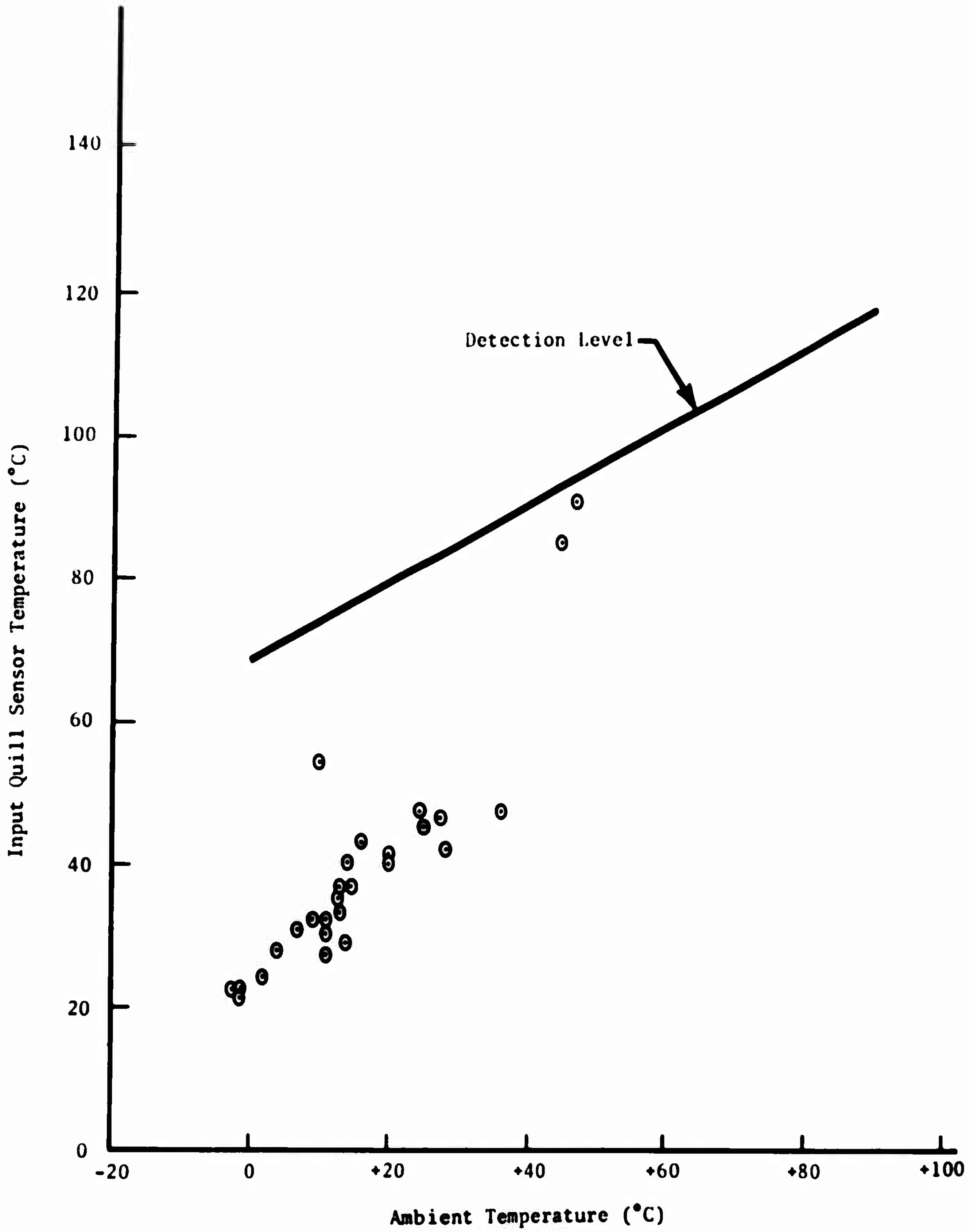


Figure 14. Input Quill Sensor Temperature Versus Ambient Temperature.

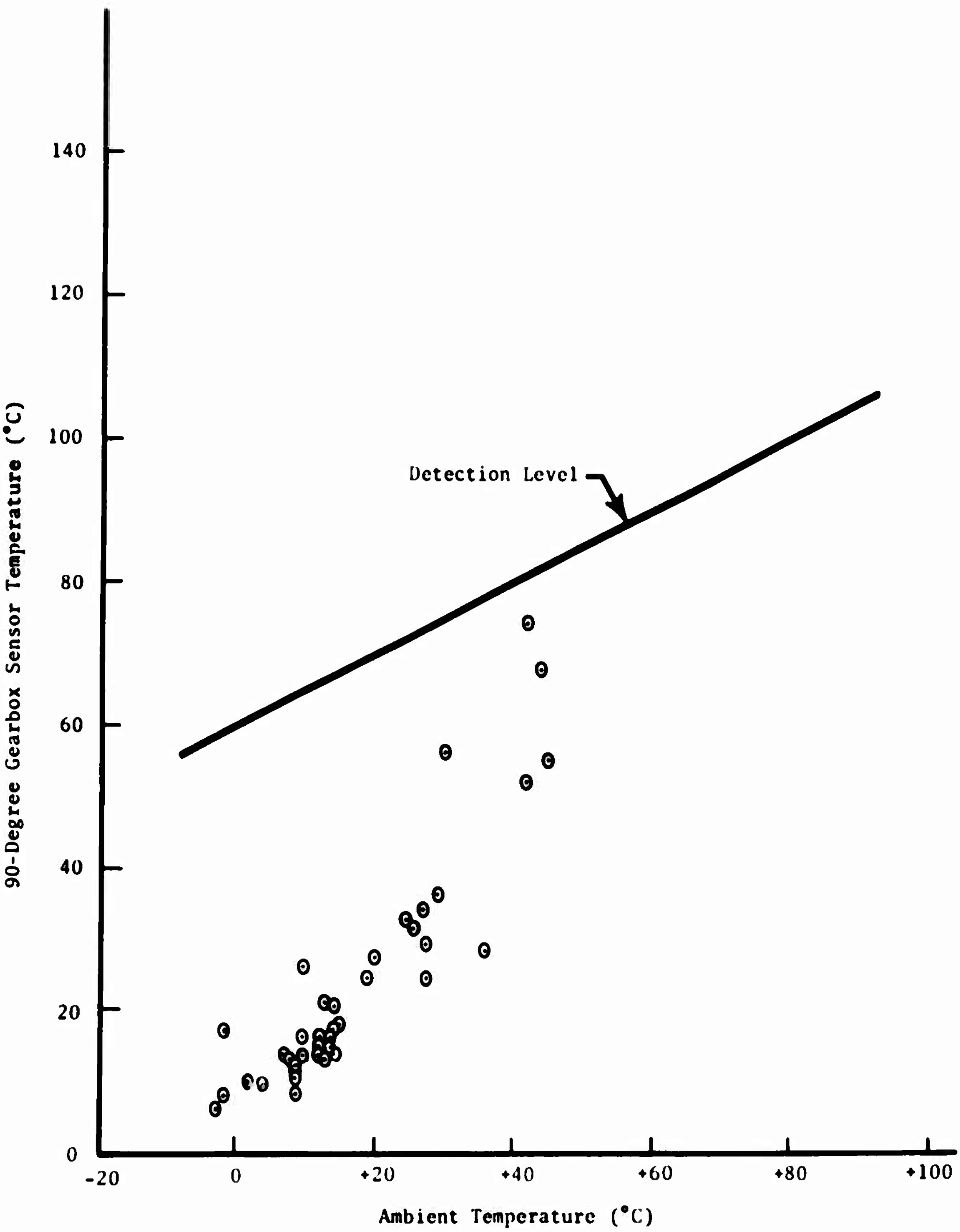


Figure 15. Ninety-Degree Gearbox Sensor Temperature Versus Ambient Temperature.

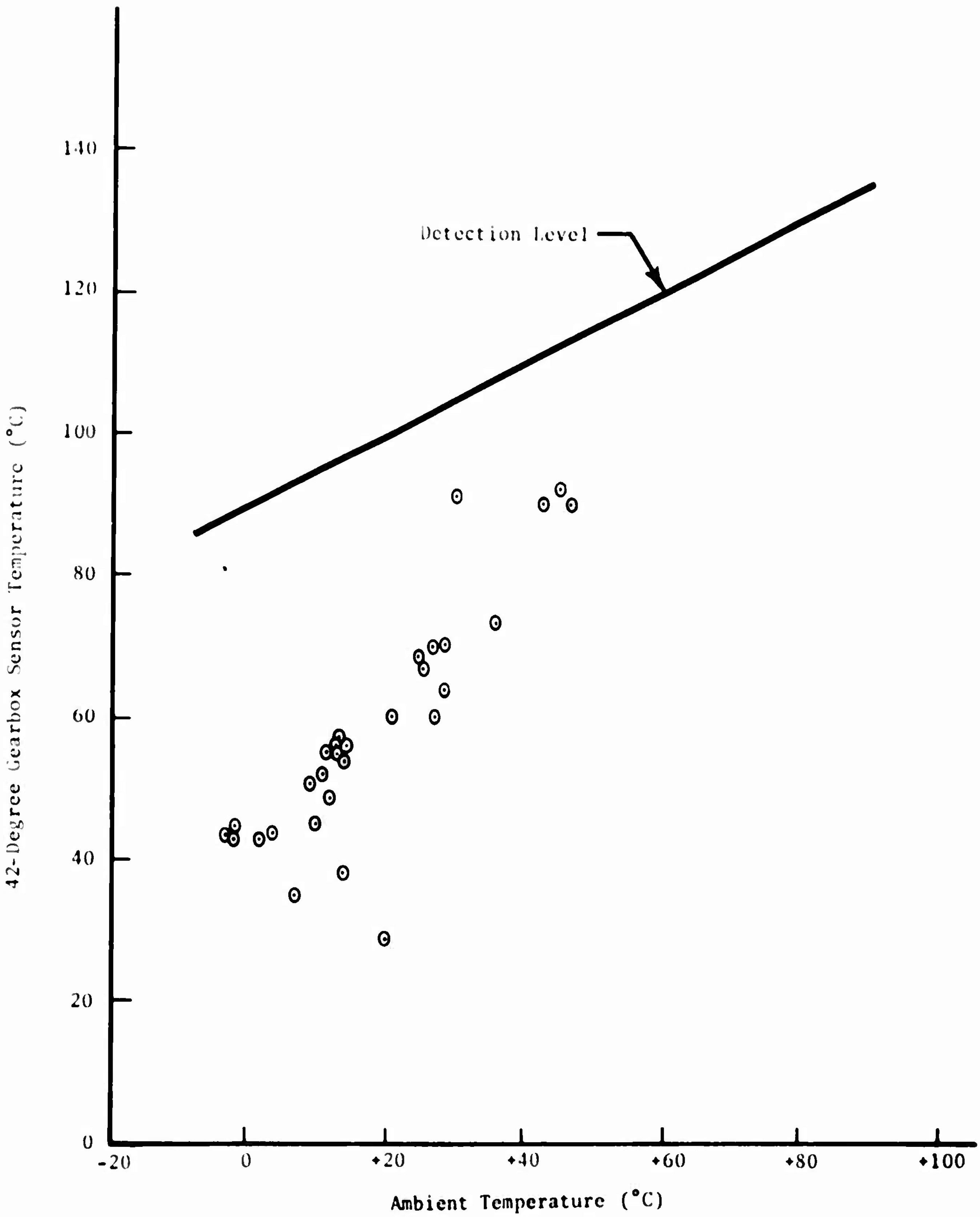


Figure 16. Forty-Two-Degree Gearbox Sensor Temperature Versus Ambient Temperature.

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13 ABSTRACT

This report covers approximately 100 flight test hours of a U. S. Army Aviation Materiel Laboratories (USAAVLABS) in-house program conducted to determine the effectiveness of the Automatic Light Aircraft Readiness Monitor (ALARM) system. This system was fabricated under a USAAVLABS (formerly, USATRECOM) contract with Bendix Corporation, which was closed in January 1963. The purpose of the ALARM system was to provide lower echelons with a tool for determining the airworthiness of an aircraft. The test program consisted mainly of comparing ALARM no-go indications with actual test aircraft malfunction data. The test results indicate that the ALARM system could be used to determine the airworthiness of an aircraft at first echelon if modifications were performed and an additional test program were conducted.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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